NISTTech

AC AND DC BIPOLAR VOLTAGE SOURCE USING QUANTIZED PULSES

Sinusoidal Microwave Generator

Description

Synthesize both AC and DC bipolar waveforms using this modified Josephson circuit for accurate, stable, arbitrary waveform generation with a predetermined frequency spectrum. Voltage pulses of both positive and negative polarity are precisely controlled and used to increase the output voltage. This accurate bipolar voltage source is for use in alternating and direct current metrology. The device has potential applications in the generation of digitally synthesized AC signals with calculable rms (short for root-mean-square) voltages, the characterization of digital-to-analog and analog-to-digital converters, and in the calibration of DC and AC reference standards and voltmeters.

This method of generating bipolar waveforms with an array of Josephson junctions drives the array with a combined input waveform consisting of a two-level broadband digital code and a single frequency sinusoidal drive. Accuracy is achieved because Josephson junctions generate voltage pulses whose time-integrated areas are perfectly quantized. Appropriate sequences of these quantized pulses can be used to generate AC and DC waveforms with precisely calculable rms voltage.

Applications

- **Digitally synthesize AC signals**
  Generate digitally synthesized AC signals with calculable root-mean-square (rms) voltages.
- **Signal converters**
  Characterize digital-to-analog and analog-to-digital converters.
- **Instrumentation**
  Calibrate DC and AC reference standards and voltmeters.

Advantages

- **Greater speed**
  Fast, reliable digital code generator.

Abstract

A Josephson quantizer is driven by a sinusoidal microwave generator whose output is combined with a digital two-level code representing a desired waveform. The result is to produce a bipolar drive signal of increased frequency and a bipolar Josephson output with voltage increased significantly. Output voltage is developed according to the relationship $V=Nnmf_S/K_J$, where N is the number of junctions, n is the Josephson junction constant voltage step number, f_S is the sampling frequency, m is an integer multiple of the sampling frequency and is .gtoreq.2, and K_J is the Josephson constant. The digital code generator receives the output of an improved modulator which incorporates a three-level to two-level transformation on the output of a standard three-level modulator in one embodiment. In a second embodiment, a modified two-level modulator produces a bit sequence where the polarity of the next bit is allowed to change only if there is an odd number of consecutive bits of the same polarity.

Inventors

- Benz, Samuel P.
- Burroughs, Charles J.
- Hamilton, Clark A.
- Harvey, Todd E.

Citations

1. J.X. Przybysz, S.P. Benz, C.A. Hamilton, A. Worsham. U.S. Patent 5,812,078 (issued 9/22/98) "Josephson Junction Digital to Analog Converter for Accurate AC Waveform Synthesis
2. S.P. Benz, C.J. Burroughs, P.D. Dresselhaus, T.E. Lipe and J.R. Kinard. 100 mv AC-DC transfer standard measurements with a pulse-driven AC Josephson voltage standard. Presented at Conference on Precision Electromagnetic Measurements, July 9-14, 2006,Turin, Italy.
3. S. P. Benz, C. J. Burroughs, T. E. Harvey, and C. A. Hamilton. Operating Conditions for a Pulse-Quantized AC and DC Bipolar Voltage Source.IEEE Transactions on Applied Superconductivity, VOL. 9, No. 2, June 1999.
4. Samuel P. Benz, Charles J. Burroughs, Jr., Paul D. Dresselhaus, and Laurie A. Christian. AC and DC Voltages from a Josephson Arbitrary Waveform Synthesizer. IEEE Transactions on Instrumentation and Measurement, Vol 50, No. 2, April 2001.

Related Items

- Article: Road to AC Voltage Standard Leads to Important Junction

References

- U.S. Patent # 6,236,344 issued 05-22-2001, expires 07/02/2019
- Docket: 98-026US

Status of Availability

This invention is available for licensing exclusively or non-exclusively in any field of use.

Last Modified: 07/29/2011